Journal of the Royal Society of Arts

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FORTHCOMING MEETINGS

WEDNESDAY, 14TH JANUARY, AT 2.30 p.m. "*Use and Abuse of Fuels*", by W. E. P. Johnson, A.F.C., C.P.A., Managing Director, Power Jets (Research & Development) Ltd. F. E. Simon, C.B.E., M.A., Ph.D., F.R.S., Professor of Thermodynamics, University of Oxford, will preside.

WEDNESDAY, 21ST JANUARY, AT 2.30 p.m. FERNHURST LECTURE. "*Plant Hormones*", by S. C. Harland, D.Sc., F.R.S., Professor of Botany, University of Manchester. Sir William Ogg, M.A., Ph.D., LL.D., Director, Rothamsted Experimental Station, will preside. (The lecture will be illustrated by lantern slides.)

WEDNESDAY, 28TH JANUARY, AT 2.30 p.m. "*Royal Portraits and Ceremonies: some new discoveries in Westminster Abbey*", by R. P. Howgrave-Graham, F.S.A., M.I.E.E., Assistant Keeper of the Muniments. C. K. Adams, F.S.A., Director and Keeper, National Portrait Gallery, in the Chair. (The paper will be illustrated by lantern slides.)

EXHIBITION OF PHOTOGRAPHS OF KUWAIT

An exhibition of photographs illustrating the development of the Arab State of Kuwait into one of the major oil producing countries in the world will be on view in the Society's Library from Wednesday, January 14th, to Friday, January 16th. The exhibition will be open from 9.30 a.m. to 6 p.m. each day without charge.

The photographs, which have been collected by the Kuwait Oil Company, are of a very high standard and have not yet been shown in this country. Fellows are invited to visit the exhibition with their friends.

"A CENTURY OF PHOTOGRAPHY"

As it is probable that the Peter Le Neve Foster Lecture on the above subject to be delivered before the Society at 2.30 p.m. on Wednesday, February 4th, will appeal to a particularly large number of Fellows, it is suggested that those who intend to be present should notify the Secretary so that seats may be reserved for them.

The occasion is in celebration of the Centenary of the Royal Photographic Society, whose President, Mr. I. D. Wratten, is delivering the lecture.

CHEAPER BUILDING: THE CONTRIBUTION OF MODULAR CO-ORDINATION

The First Alfred Bossom Lecture by

M. HARTLAND THOMAS, O.B.E., M.A., F.R.I.B.A., M.S.I.A.

Chief Industrial Officer, Council of Industrial Design, delivered on Wednesday, 10th December, 1952, with Howard M. Robertson, M.C., A.R.A., S.A.D.G., President, Royal Institute of British Architects, in the Chair

THE CHAIRMAN: I feel it is always a little disagreeable for the lecturer to be, as it were, exhibited, and to have a kind of "obituary notice" of his distinctions mentioned from the platform, but I am afraid that Mr. Mark Hartland Thomas cannot escape. He is too fine a figure of a man to pass unperceived, and I am going, if I may, to make just a brief reference to him.

I think very many people in this room know him personally and well, but for those who do not I should like to say that the lecturer to-day has had a long experience as an architect in practice, and knows his subject from the practical angle. He has been, since 1947, Chief Industrial Officer of the Council of Industrial Design, and he has been distinguished as a lecturer because in 1949 the Royal Society of Arts' Silver Medal was awarded to him for his paper on "Industrial Design in the Engineering Industry".

He was a member of the Exhibition Presentation Panel for the Festival of Britain, and he has been co-leader of the "Design for Production" team which visited the United States of America in connection with the Anglo-American Council of Productivity.

Especially I should like to mention that he has been Chairman of the Royal Institute of British Architects' Science Committee from 1945 to 1950—five years' hard labour! In 1945 and 1946 he represented the Royal Institute, and was leader of the Ministry of Works' team that went to Germany to study civil engineering and survey building progress.

He is also the modest inventor of a space framing roofing system, Unitectum, which is his own pet child; and he is an author with whom many of us are acquainted.

So much for Mr. Mark Hartland Thomas; but I should like, before I ask him to read his paper, to mention in particular Mr. Alfred Bossom, whose generosity has provided this lecture. The series of Alfred Bossom lectures is an endowment from Mr. Alfred Bossom, who is blushingly sitting in this room. He is very well known to us all and, of course, particularly to this Society; his never flagging energy, his splendid generosity and his zeal have been in the forefront of architectural and building industry matters ever since I first knew him.

It was Mr. Alfred Bossom who started many years ago the Building Industries Council's Review which grew into the Building Industries National Council. That that Council has more or less expired to-day is through no fault of the man who had the extraordinarily fine idea of bringing it to life. It was the war and the kind of troubles that occur in a large industry which prevented it becoming the splendid machine which it could have been.

I asked Mr. Bossom what was in his mind when he endowed these lectures, and I hope I am not being indiscreet if I read the text of what he originally said to the Society when he endowed them:

> I have for some time thought that there is a gap in the proper dissemination of all that is new in matters pertaining to modern architecture amongst the lay public, and I believe our Society is the proper agent to fill this gap. While learned articles in the specialist Journals may inform practising architects of the many and rapid advances in materials and building technique being made, particularly in the United States of America, very little if anything is being done to acquaint the educated public with these advances.

Well, the first link in that chain is being forged to-day with a lecture on this particularly vital subject of cheaper building, which Mr. Bossom is so interested in; not, I may say, on his own account, but because he feels that the public expects cheaper building and ultimately has to get it.

The following lecture, illustrated with lantern slides, was then delivered:

THE LECTURE

My subject has its origin in the fourteenth century with the reintroduction of the brick into this country, after an absence of nearly a thousand years since Roman times. I mention this, not because I am going to treat the subject historically, but to emphasize two points. Dimensional co-ordination is not concerned only with sheet materials and with light and dry construction, but we must come to terms also with brickwork and with wet and heavy construction: the current distinction between "traditional" and "non-traditional" building is unreal and confusing, and should be discarded. The other point is that the problem to-day of co-ordinating the dimensions of building elements is the result of a long process, extending over hundreds of years, in which more and more elements have been prepared in the factory to predetermined dimensions. Almost every factory-made unit that one can mention—beginning with the brick itself, and going on to baths, fireplaces, doors, windows—used to be made on the site or in the builder's own workshop. In recent years this process has greatly accelerated: the number of different ready made parts has increased, and so has their size; electrical and mechanical elements are added to the list, considerable sub-assemblies such as kitchen fitments are produced, sheet and panel materials and units are offered on the market for the construction of walls, floors and roofs.

The present situation is the result of this cumulative process. Fifty years ago the ready-made elements in a building were few and small; they were easily absorbed in the mass of hand-made construction on the site. Now they are so many and so large that they have begun to jostle one another. There is not enough dimensionally fluid site-work intervening as a cushion between them,

so that fitting them together on the site has become proportionately expensive. The case for dimensional co-ordination, as one of the chief opportunities at the present time to lower the cost of building, is that the economies that one has reason to expect from standardization and quantity production of the parts are at present being dissipated in the drawing office and on the site in efforts to fit them together into whole constructions. This difficulty has, since the war, been aggravated rather than eased by the very great increase in standardization within the different branches of manufacture, without co-ordination between one branch and another: now that there are fewer standard windows to choose from, it is even harder to find one to agree with a choice of door-frames and sheeting materials, themselves offered in fewer alternatives.

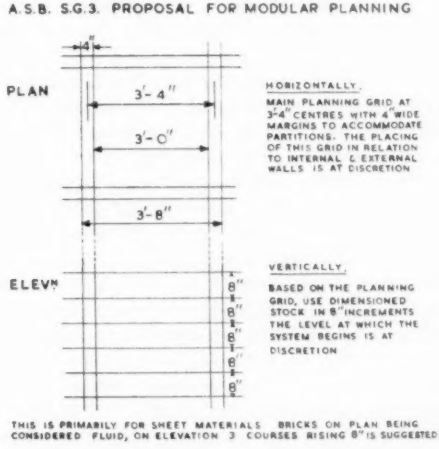
This statement of the situation will, I believe, be generally accepted. What is not so well known is that, especially during the past six years, a line of development that seems to point to a solution has been quietly gathering momentum. We can pride ourselves that it has chiefly taken place in this country. This will enable me to devote the greater part of this paper to reporting upon current British developments. I will preface the reports with a short account of the origin of the line of development that I am reporting; and I hope to conclude with proposals for co-ordinating the development itself and increasing its pace.

In February, 1946, the Ministry of Works' Standards Committee issued its second report and went into recess. The co-ordination of standard dimensions appears to have been attempted by the process of collecting all the existing dimensions laid down in British Standards and of studying them to find the highest common factor. When this proved a failure, they recommended the adoption of 3 inches "as a convenient multiple", but expressly laid down that it should not be applied as a rigid system for co-ordinating dimensions. In effect, this report declared the problem to be insoluble and left it to the process of natural selection.

At the same time other researches were discovering a way round the *impasse*. At the end of 1945 the Ministry of Works despatched a team to Germany under the auspices of the British Intelligence Objectives Sub-Committee, to survey German building and civil engineering and to select those subjects that were likely to repay further study. Mr. Richard Llewelyn Davies and I were the architect members of the team, and he has since taken a prominent part in the developments that I am about to describe. One of the subjects that we recommended for further study was the German wartime system of dimensional co-ordination. This had been laid down by a Professor Ernst Neufert, and given the force of an official regulation by the Government.. Its interest lay in the way it cut through the welter of unco-ordinated standards and customary sizes by prescribing a large-scale planning grid for the design of wartime buildings—2·50 metres for industrial buildings and half this, 1·25 metres, for hutments, cantonments and other living accommodation. Neufert intended that the imposition of this single broad dimensional grid should achieve significant economies, by simplifying design and erection, and by acting as a magnet to influence the dimensions of all subsidiary components to fall into phase with the

grid. We found in Germany, even after the fall of the Nazis and the consequential release from compulsion to apply the system, sufficient evidence of its effect upon architects, engineers, builders and manufacturers to justify its study as a possible lever to get British researches moving again.

The Ministry of Works suggested that this subject, one of ten that we had recommended, was essentially an architectural one and should be allotted to the Royal Institute of British Architects for further development. This I was able to arrange at the Architectural Science Board and a study group was formed in January, 1947. The work of this study group was amplified late in the same year by a committee of the British Standards Institution, under the chairmanship of Mr. S. Rowland Pierce. The two bodies worked so closely together that their


DIMENSIONAL STANDARDIZATION
A.S.B. S.G.3. PROPOSAL FOR MODULAR PLANNING
4"
PLAN
3'-4"
3'-0"
3'-8"
ELEVN
8"
8"
8"
8"
HORIZONTALLY:
MAIN PLANNING GRID AT 3'-4" CENTRES WITH 4" WIDE MARGINS TO ACCOMMODATE PARTITIONS. THE PLACING OF THIS GRID IN RELATION TO INTERNAL & EXTERNAL WALLS IS AT DISCRETION
VERTICALLY:
BASED ON THE PLANNING GRID, USE DIMENSIONED STOCK IN 8" INCREMENTS THE LEVEL AT WHICH THE SYSTEM BEGINS IS AT DISCRETION
THIS IS PRIMARILY FOR SHEET MATERIALS BRICKS ON PLAN BEING CONSIDERED FLUID, ON ELEVATION 3 COURSES RISING 8" IS SUGGESTED

A scheme circulated privately for experiment by the R.I.B.A. Architectural Science Board in March, 1948, in which a 4 inch tolerance to allow for thickness is combined with the 40 inch human-scale planning module

findings can be reported as one. The former has now been wound up after publishing its report in the R.I.B.A. *Journal* (April, 1951): the B.S.I. Committee continues, having published its first report last year, B.S. 1708: 1951.

Our findings have been that Neufert had the right idea in plunging for a definite large planning module, instead of trying to tinker with the multiplicity of existing standards, but that in choice of module he went to too high a figure—1·25 metres or nearly 4 feet 1 inch. This figure of 1·25 seemed to have been arrived at arithmetically by progressive halving from 10, instead of being related to custom or human requirements. Also, it is characteristic of German building for everything to be rather over-scaled in comparison with British practice. We

examined British and foreign examples in considerable detail and came to the conclusion that some figure rather over 3 feet would be the best one for a centre-line planning module. This opinion was based upon the shoulder-width of a human being, plus tolerance for movement, plus constructional thickness on either side to centres of support. This gives a basic planning unit for the smallest compartments and recesses—doorway, staircase, passage, bathroom, bed recess. Twice this module, nearly seven feet, gives a door-height including frame, or room for the length of a bed or bath. This concept, we argue, is fundamentally right because it is securely founded upon human scale, the most enduring factor in architecture, rather than upon the temporary convenience of manufacture at any particular time or place. But human scale has its importance in manufacture as well, and more still in assembly, for it controls what a man can lift and handle. The economy of machine-production, with ever larger and more powerful machines, demands the production of larger pieces: limitation to human scale ensures that they are economical to handle on the job.

The exact figure of 3 feet 4 inches was chosen, out of several of this order which would have maintained the essential characteristic of human scale, partly because it is near to a metre (3 feet 4 inches equals 1·0160 metres) which might make it easier later on to conform to the metric system, but chiefly to agree with the American 4 inch cube system, which although it has its limitations is the only established modular system as yet in operation. In this again I submit that we were right. People in Britain have too long regarded building as a sheltered home industry. Our export trade in building components and entire ready-made buildings is already substantial, as I shall be describing later; so is our importation of components. In this matter of dimensions we would neglect the international aspect at our peril. The parochial solution, which has been advocated, of basing our dimensional system solely upon the English yard is to be avoided; though the 3 foot size is likely to appear as a preferred dimension in stock material based upon a centre-line module of 3 feet 4 inches.

Study and discussion at the Architectural Science Board and the British Standards Institution were all along amplified and extended by the professional and industrial work of members and of those who came to give evidence. In this way study had its effect upon action, long before it emerged from the back room as reasoned proposals in a report. A mile-stone in development was the report of the Ministry of Education's Technical Working Party on School Construction, which reaffirmed the general conclusions of the Wood Report as to the need for modular planning in school construction, but took note of the difficulties that had arisen from the 8 foot 3 inch module, which does not divide easily and leads to rather coarse planning, and recommended a bay spacing of 10 feet which can be divided into three times 3 feet 4 inches. This was adopted and now forms the framework of the Ministry's current work of development.

Before coming to practice, there is one important point of theory that must be mentioned: it is the question of thickness. This question arises as soon as anything beyond a straight run of walling is proposed. If the module is located on the centre-line, the external units at a corner will be greater than module, and

the internal less, by an amount equal to half the thickness of the wall. This is the condition at a salient angle on plan: at a re-entrant angle it is reversed. In elevation or vertical section a similar problem occurs, but less frequently, because changes in floor and roof level are more rare than variations in the compartmentation of the plan. There is no complete theoretical solution and we shall see how the different designers are coping with it in practice. The American modular system, Project A62 of the American Standards Association, derived its 4 inch cubic module from what was considered to be a convenient partition thickness, thus seeking to solve the most intractable problem by making it the common denominator for all sizes. The Architectural Science Board adopted this concept of the 4 inch thickness and added it to that of the 40 inch planning module, which now appeared as a 4 inch strip in both directions at 40 inch centres. This was circulated privately in March, 1948, for experiment. Such an arrangement assumes the manufacture of stock material in dimensions conforming to 3 feet, 3 feet 4 inches and 3 feet 8 inches. This, I think, might be extended by another 4 inches either way to add 2 feet 8 inches and 4 feet to the vocabulary. At the same time 8 inch vertical increments were suggested. This being one-fifth of 40 inches would enable proportions other than square and double square to occur: in particular, one to one and three fifths, which is close to the Golden Section.

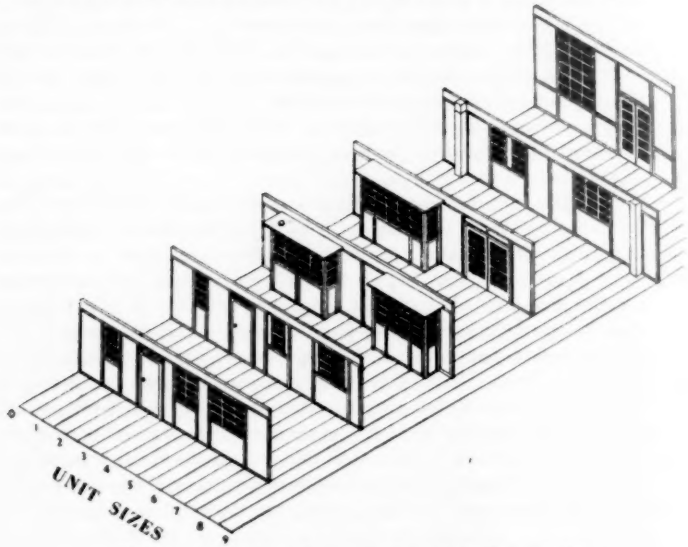
The maintenance of the larger concept of the human-scale planning grid was, and continues to be, of prime importance and should never take second place to schemes for solving the problem of thickness. The American system which took this latter course is making very slow progress through the mass of detail, having hardly got beyond clay products and windows, though there are over 600 manufacturers producing modular products in these categories. There are signs now of the use of a larger planning grid, usually one of 4 feet which in our view is rather too large for economy.

But there is other American work more in line with developments here. The system developed by Walter Gropius and Konrad Wachsmann for the General Panel Corporation is based upon a 40 inch centre-line module and exhibits the pure milk of theory in its treatment of the thickness problem. All panel-joints in floors and ceilings, as well as in walls and partitions, divide on a 45 degrees mitre within the panel-thickness, thus providing complete flexibility in plan and elevation on the grid lines, the panels bearing load without the assistance of a framework. I have made this the first example because it illustrates the theory so well, but I believe it to be too perfect for our present stage of development. The module itself is likely to have a greater influence than the details, brilliant though they are, for Professor Wachsmann told me that he has in train at the Illinois Institute of Technology a comprehensive programme of research for the Federal Housing Agency which is likely to result in the adoption of the 40 inch module.

Returning to this country for my next and subsequent examples, I mention the L.M.S. Unit Station—architects W. H. Hamlyn, Leslie Martin and Richard Llewelyn Davies. This was the beginning of a building programme which later became a casualty of nationalization. Like the previous example it was the product

of several years' development which emerged around the year 1946 and had a considerable influence upon the studies that I have been describing. Like it, too, it is planned on the 40 inch module and it makes provision for partition-junctions at every intersection of the grid internally by means of a hollow post of panel thickness; but unlike the Gropius system this is not done externally, where the concrete dado panels and the enamelled iron upper panels conform to the full 40 inch width. Unlike, also, is the placing of the columns off the main lines. This device we shall meet again: it is claimed by many to be an essential simplification of the problem at the present stage of development, but none, I think, would claim that it provides a satisfactory permanent solution for general adoption. In this particular case the continuous platform canopy, separately supported, allows the inclusion of non-modular constructions and even of rooms already existing.

Evidence next comes from Uni-Seco, Limited, a firm with an immense record of successful construction to its credit. Beginning in 1940, they supplied during the war no less than six million square feet of buildings for Service requirements in over five hundred different plans, ranging in size from telephone kiosks to canteens seating 3,000 people. After the war, they were contributing standard bungalows to the housing programme at the rate of 400 houses per week. Output of parts for all types of building continues at the same scale.



Uni-Seco : system of construction used for wartime buildings; lay-outs were designed on a square grid of 3 feet 2⅛ inches—the width of the No. 1 Wall Unit—but carried out in a variety of standard panels that added up to the grid dimensions without conforming to every intersection

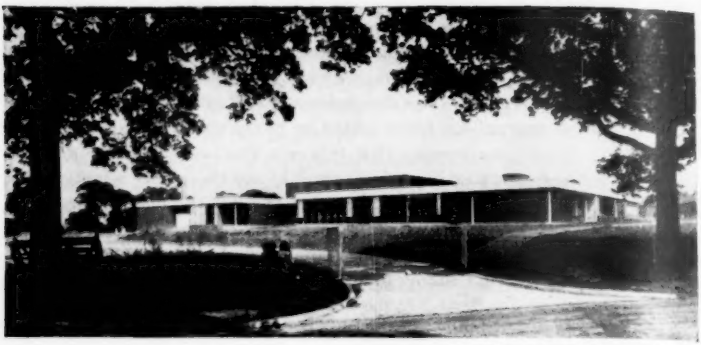
Until 1944 fully modular planning was not attempted, but flexible planning of a wide variety of buildings was based upon their No. 1 Wall Unit. This was a load-bearing panel of asbestos-cement sandwich construction, incorporating a timber frame, and measured 3 feet 2⅛ inches wide. Preliminary plans for buildings were laid out on a square grid of this dimension and at the detailing stage a variety of standard panels was utilized which added up to the grid dimensions without conforming to every intersection. That this was the basis of their immense wartime output is weighty evidence in support of my thesis: the adoption of a human-scale planning module, without waiting to solve the detailed problems of dimensional increments, got production under way rapidly and proved to be a reliable tool throughout an enormous programme of construction. The same, I believe, would hold for the building industry at large.

An important point for flexibility was the maintenance of the same thickness for external and internal walls. For plans divided up into small rooms these walls carried the roof; for larger spans plywood box-girders and columns were added, externally or internally, to abut against the walling. This placing of columns off the grid-intersection is still maintained in the latest model.

Mr. W. A. Balmain, the joint managing director, whom I interviewed together with Mr. R. G. Emsley, their architect, kindly let me see an internal report on modular planning addressed to their Development Committee in June, 1944. In this the argument for adopting a standard dimensional increment, in combination with the grid-planning which was already well known to the firm, is clearly reasoned. It shows also that little help can be obtained in the choice of the actual module from existing British Standards and customary sizes. As a result of this study a 40 inch centre-line grid was adopted, with panel widths ranging from 10 inches to 40 inches in 10 inch increments. This was developed in two systems, a modular steel frame having wood inserts, to which any form of cladding could be applied on the site; and the continuation of the structural panel system, now on a modular basis. The frame system soon had to go into cold storage because of shortage of steel. In both systems the constant wall-thickness was maintained and junction-boxes or timber posts equal to thickness occurred between each frame as for the L.M.S. Unit Station.

This panel system is still in use for export housing, but they have been forced off it for home use because, Mr. Balmain told me, architects cannot think in 10 inch multiples. To assist architectural arithmetic they have now standardized their Mark VII on an 8 foot major grid with a 6 inch minor grid for detailed planning. An innovation in this model is the provision of pre-formed corner, tee and cruciform units for wall junctions. The panel is still the original structural panel, complete with in-filling and of constant thickness; columns are applied to the panel-face, off the grid-intersections.

Mr. Balmain assured me that if there was a concerted move to adopt the 40 inch module generally, Uni-Seco could easily go back to it, especially if there was a prospect of conformity with other systems and consequent interchangeability, which he would welcome. Uni-Seco roof panels are, for example, already sold separately for use with any method of construction.



[By courtesy of Architectural Design

Summerswood School, Boreham Wood, Herts. General view of a school on the new Hertfordshire system, which has changed from the 8 foot 3 inch module to one of 40 inches

Summing up the present stage of their development, he said they were at a compromise: they do not attempt to carry strictly modular design right through. They design and tender on the modular basis, but having got a job, they proceed on the basis of job-standardization. Drawing office and estimating time is saved by modular planning; and job standardization afterwards reduces the number of different wall-units by some 25 per cent which pays for any special units required. They emphasized that a modular system needs, in the last analysis, something you can cut, like a plank, to make the final adjustments; otherwise provisions for every contingency become too expensive. This was one opinion among many that agreed in condemning the cult of perfection in modular design and in emphasizing the need for a combination of site-work and manufacture. Somewhat similar evidence came from Mr. Z. Pick, consulting engineer to Orlit, Ltd., a firm that provided concrete hutments in wartime on a 6 foot planning grid, but now are handling design more flexibly in response to post war demands.

I have already referred to the adoption of the 40 inch module by the Ministry of Education. Previous to that, a large programme of school construction on the former 8 foot 3 inch module was being realized in Hertfordshire, under the County Architect, Mr. C. H. Aslin, amounting to more than forty schools built between 1946 and 1951. The 8 foot 3 inch system is still in operation for the majority, but six new schools are on the 3 foot 4 inch, which other local authorities have now adopted, including 15 new schools now in construction for the London County Council.

The reason for the adoption in Hertfordshire of a modular system of design, using a high proportion of factory-made units, was the need to save time, without overstepping financial limits. This is also the basis of the pioneer work now in

train at the Ministry of Education. The method has been completely justified on the basis intended, for average construction time has been halved in comparison with ordinary building, whilst keeping well within the figure allowed per place. This supports my main thesis, for under different conditions and on a nation-wide basis the saving in time due to modular planning could be translated into a saving in money.

The latest Hertfordshire design can be seen at Summerswood School, Boreham Wood. In changing from the 8 foot 3 inch to 3 foot 4 inch, the chief difference apart from the smaller planning grid is the removal of columns from the line of wall to a free-standing position in the centre of a square module. This is considered essential as the column is seen as a bar to progress in developing the modular screen itself. The basic unit of the screen is a hollow plastic panel in an extruded aluminium frame, with provision for four-way junction at every grid-intersection.

Mr. William Tatton Brown, Deputy County Architect, and his colleague Mr. Bruce Martin, discussed with me the next stage in development. They were emphatic that the 3 foot 4 inch human-scale planning module is indispensable, but were being forced off the completely interchangeable detail of screens by considerations of cost and availability of materials. The plastic panel was really the only completely satisfactory one in performance and, as it was inherently too expensive, debate upon the exact determination of panel width and thickness rested upon an insecure hypothesis, because the panel could be hardly said to exist as yet. In current work, therefore, they are using different panels straight from the manufacturer with a tongue-and-groove joint, running straight ahead regardless of the grid and cutting them at a grid line where an intersection occurs. For the future, if manufacturers wish to produce units in conformity with the module, they suggest that two kinds should be made—full-size panels 40 inches wide less only manufacturing and erection tolerance; and end-units of module width less half the thickest possible partition or wall, which would involve using a filler-piece for abutting against thinner walls. Here one is reminded of the Uni-Seco compromise position and their demand for a "plank" which one can cut.

Beside their current production relying upon steel frame from Hills (West Bromwich) Ltd., the Hertfordshire architects are developing other steel, concrete and timber frames, including a version in hardwood frame and plywood with C. D. Productions Limited, for which Ove Arup and Partners are the consulting engineers. Although it is intended as an alternative and is on the same 40 inch module, the parts are not yet interchangeable with those of the steel-aluminium-plastic version, though it is hoped to achieve this later. Wooden posts off the grid-line and a deep roof slab of plywood "punts" faithfully reproduce in timber the Hills construction of steel. The panels (3 inches external and 2 inches internal) are a sandwich of hardboard or plywood faces over a soft-board honeycomb core with a solid timber frame to the panel and a brilliantly simple joint. Mr. E. Collins, Works Manager of City Display, told me that these panels are already in production and separately available to buy. He is planning

to generalize the system for house construction on the 40 inch module, which he is positive is the right one.

The development work at the Ministry of Education, under Mr. S. A. W. Johnson-Marshall, Chief Architect, consists in user research in conjunction with educationists, technical development of a number of modular systems with different manufacturers and contractors (among these is the Bristol Aeroplane Company with their well-established system on a 4 foot module), and the building of actual schools for local education authorities as the "first off" in each particular system. The decision, taken on grounds of cost and educational convenience, to raise the main classroom block to three or four storeys increased the technical difficulties, at the same time as broadening the relevance of the experiments to the needs of the building industry in general. Mr. Johnson-Marshall emphasized to me that theirs was an empirical approach to modular theory, the first job was to get a flexible closed system from each manufacturer working with the Ministry; later, it was hoped, they would come to terms with each other upon interchangeability of parts between the systems. He also laid great stress upon his method of cost analysis which was related to the modular system and was therefore readily available at the design stage of components.

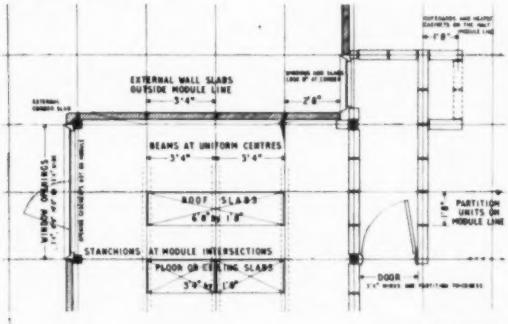
At Wokingham School, which I visited with Mr. David Medd, one of the Ministry of Education architects (contractors: Gilbert-Ash), the stanchions are placed on the grid-intersections and the partitions are centred on the grid lines: but the external walls are placed off the lines at the outer faces of the columns. They are of dry construction of concrete slabs lined with site-fixed hardboard, but the internal partitions are of wet *in situ* construction, consisting

[*By courtesy of H.M.S.O.*

General view of Wokingham School, Berkshire, under construction. This is the first of several schools now being developed on the 40 inch module by collaboration between the Ministry and different manufacturers

of honeycomb gypsum slabs of storey height and non-modular width, with poured gypsum joints. They are thicker than the stanchions so that these can be covered with fibrous plaster and concealed flush. Floor and ceiling beams and slabs are of modular sizes and drop neatly into the pattern. Ceiling slabs are of vermiculite concrete, which can be cut, so that the casting of specials is avoided.

Considerable care has been devoted to the vertical module, which is based upon the 2 feet high external slab. A full 2 feet has been allowed for the constructional depth of floors and roofs: this is a telling example of the importance and economy of standardizing upon a generous size, instead of raising a host of problems by cheeseparing.



By courtesy of H.M.S.O.

Wokingham School: the horizontal module; stanchions and partitions are on the grid-lines, external slabs outside them

In Mr. Medd's opinion the way forward seemed to lie in modular design on the 40 inch grid, tempered by job standardization; though each job would contribute something to the general pool of ideas and of units available generally. He was anxious that many other authorities and private firms should undertake development work so as to broaden experience and increase the vocabulary.

Mr. F. W. L. Heathcote of John Brockhouse and Co., one of the manufacturers working with the Ministry of Education, confirmed these opinions. He added that as a manufacturer the modular idea held out considerable promise to him. It was already helping him to launch a new type of steelwork, cold rolled sections, as it avoided the traditional practices of his own works and of structural steel contractors generally. Since the war he had been developing structural steel for schools and other buildings, but had found so many alternatives that it was difficult to get on to a production basis. Modular planning might provide the solution. Whilst he was very willing to work intensively upon one system and thought it well worth while, he hoped it was not too far ahead to supply interchangeable elements for general building. No individual manufacturer could study the general point of view and he felt the need of some centrally placed authority to co-ordinate development between the different systems.

The diagrammatic plan for the Brockhouse system is interesting to compare

with that for Wokingham. Stanchions are kept to the grid-intersections, except at re-entrant angles where they are doubled, and they are lost in the thickness of partitions and external walls, which follow the grid lines, with additional thickness to the outer walls. This avoids awkward junctions, horizontally and vertically, between partitions and external walls in the same line, which occur at Wokingham.

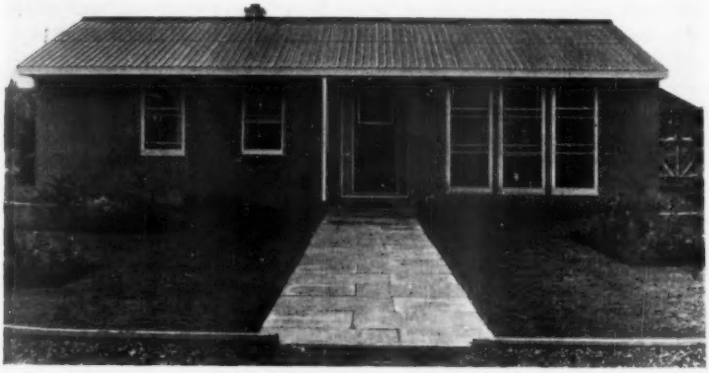
We come now to housing. The Wates house, according to their architect, Mr. K. W. Bland, began development in 1944 on a 12 inch modular system, but found that the adaptability afforded by modular planning was unnecessary for coping with two or three standard plans and, as Wates are concerned chiefly with the concrete external units, it was cheaper to relate these to standard windows and to let the internal dimensions take care of themselves. This is typical of experience in house production within closed systems in face of the diversity of existing British Standards. It says nothing against the substantial savings that a widely adopted modular system might provide. Indeed, Mr. Bland said he would be very glad to use modular components if they became generally available.

Mr. Rodney Thomas, one of the architects of the Arcon post-war bungalow, is at present working upon a flexible house system for the Arcon group of manufacturers to export. His experience with the bungalow convinced him that even the quantities in that programme were not enough to realize the savings of flow-production. Modular planning, with interchangeable parts, is needed. Besides, his group's previous export house was frequently receiving enquiries for modifications; consequently, the new design is an adaptable system on the 40 inch module. He insists that to simplify the problem, and to permit freedom of subsequent development, equipment as well as the structural frame must be kept separate from the panel screens. He is much concerned with the problem of tolerance and designs a slip-joint at every panel joint. He, like others, is anxious that developments should proceed on a broad front, so that the vocabulary available to all designers would be extended. He would be glad if such development should relieve the architect of attention to structural detail and free him for his chief functions of planning and appearance-design.

Mr. A. F. Hare, consultant architect to Structural and Mechanical Development Engineers of Slough, has been concerned with a number of export houses designed for different parts of the world. He tells me that invariably the design is prepared on a modular basis, because this is economical of drawing office time. The module is frequently one of 4 feet for economy of the wallboard lining; frequently too when the tender has been accepted, production is detailed on a basis of job-standardization, departing from the module where this is advantageous. The prototype transportable bungalow is designed on this basis and variations on the same theme are designed in response to particular demands. A scheme for houses in India was designed on a 3 foot 2 inch module for adaptation to half a dozen different arrangements of plan. The walls and partitions were of load-bearing cellular concrete panels with aluminium frames, located on the grid lines, with a very simple joint.

The Riley-Newsum Housing Department of Messrs. H. Newsum, Sons and Co., of Lincoln has, since the end of 1949, built up a very substantial export business in the face of strong and established competition from overseas, particularly from Scandinavia. To sell British houses in Canada under the noses of American competitors demands a very sound basis in design to provide a more attractive product. That basis, Mr. James Riley assures me, is the 40 inch module. This evidence, from the world market where the chill winds of competition blow, is of great significance to the sheltered building industry at home. Mr. Riley claims that by means of a modular system that standardized components, without standardizing the structures made from them, they were able to reproduce closely the basic plans submitted by potential purchasing authorities and even to achieve economy in overall areas and minimum sizes of individual rooms. Such close planning was not afforded simply by working to a module: it had to be the right one—40 inches. A 4 foot module would have wasted space in passages; a 3 foot one might have pinched too tightly and demanded the doubling of it to 6 feet in places where 3 feet 4 inches would be sufficient.

The grid-lines lie on the internal face of outside walls and on whichever face of the partitions is convenient. It is not, therefore, a centre-line module. The panels are of timber and take the load without framework. Panel-widths are generally 3 feet 4 inches with a make-up panel of 3 feet $0\frac{7}{8}$ inches. Ceiling and floor panels carry straight through over and under the partitions. The thickness-problem is easily mastered in this material: for example, a make-up piece in the external wall is added unnoticeably as an additional vertical weatherboard. An instance of the effect of modular planning in bringing manufactured materials into phase with it was mentioned by Mr. Riley: plasterboard is now available



Riley-Newsum export house: a substantial export business has been built up on the 40 inch module, which allows the standardization of components with variable planning of the structures made from them

40 inches wide, less $\frac{1}{8}$ inch tolerance. There were several other examples in the schools programme.

Mr. Riley, as did Mr. Johnson-Marshall, attached great importance to the speed afforded by modular planning. This obtained right from the drawing board, through all stages of production, to the setting out and erection on the site. This was much appreciated by realtors in North America. Speed is money; development of land was sometimes accelerated twofold. We could similarly speed up the turnover of capital in the building industry at home. He looked forward to the achievement of interchangeability of parts between the different systems now current; and even the small housebuilder who laid down his plans on the modular grid should be able to shop around for ready-made parts that suited his business and combine them with brickwork and other *in situ* methods to the best economy. To achieve this he felt the want of a clear lead from a central authority.

Might I make an appeal to the Minister of Housing to give such a lead? It could take a permissive rather than mandatory form, by an announcement that areas of houses may be calculated in so many square modules as an alternative to a total rendered in square feet. This would at once give a sense of direction to development. The area of a house of 900 square feet might be expressed as 104 square modules of 3 feet, or as 84 square modules of 3 feet 4 inches giving an advantage of some 35 additional square feet to the two alternative modular versions. Standardized building, like ready-made clothes, must be allowed to fit a little loosely: we have for too long been trying to get tailor-made architecture off the hook.

As my last example I crave indulgence for a small thing of my own. It is an attempt to apply the modular idea to roof construction, whilst other systems have been more concerned with walls. A prototype is now being made to a 6 foot 8 inch grid: the trade-name is Unitectum, which is trade-mark Latin for "unit roof." Each bay is roofed with a separate pyramid and the tops are joined together in both directions making a rigid space-frame. The prototype is designed in steel for a 60 foot square clear span; column positions can be varied within this limit and bays can be added or taken away at will.

Before summing up we must look at the architectural implications. From the public viewpoint, there will be a subtle difference in style. Hitherto architectural design has begun with a plan of a certain size and subdivided it into its parts, creating a self-contained composition. Modular architecture proceeds in the opposite manner: it is additive instead of subdividing: one unit is added to another and it matters very little where you stop; Gertrude Stein anticipated this with her Continuous Present—"A house is a house is a house." But, after all, towns develop in this additive fashion and the public may well find that modular architecture produces a quieter and more harmonious civic design, one that is content to remain a background to the passing show.

For architects it is more difficult to swallow: it seems to deny their birthright as designers. Architects are often accused of being the mouthpiece of unstandard elements, making small variations to assert their rights. This is understandable,

since standardization so often means uglification—witness the standard metal window. But let us beware of losing an opportunity to control a movement that will go ahead without us if we refuse. And I believe we shall find a new freedom in it—a freedom, as Mr. Rodney Thomas pointed out, from harassing detail, and the scope for larger things.

Consider the economic side. The design element in building is assessed at the architectural fee of six per cent. In mechanical engineering this is the design cost for a standard product, twenty or thirty per cent being allowed for a tailor-made design. In architecture we strive to give Savile Row service at a reach-me-down cost. No wonder it is said that only bad architects can be successful. Modular design might allow the good ones to be successful and the successful to be good. Also: it could arrest the blind-alley movement towards standardized complete buildings, which are anathema to architects.

I should like to sum up by making a proposal. The British Standards Institution has accepted the recommendation of its committee that there should be a small architectural unit for practical research. This proposal is now going the rounds of the departments concerned. It is hoped by research to revise British Standards into co-ordinated modular stock. I support this aim wholeheartedly; but preparation for this paper has shown me that two more things are needed—promotion and a referee. I have found wide agreement about the need for a centrally placed authority to adjudicate between designers upon such things as net dimensions and jointing details, so as to secure interchangeability between systems. This function could be performed by a government research unit, and so could promotion to some extent. But such a unit is always at risk, through its sense of public responsibility, of getting bogged down in detail unable to take a strong clear line. Also, it might not take full advantage of private development work such as I have been reporting, although the British Standards Institution has long experience of voluntary work by members of its committees, to which I pay tribute.

I propose, therefore, the foundation of a new private society—The Modular Society. Many people are at present urging architects, engineers, builders and manufacturers to work more closely together. Our professional code prevents us going into business together, but it does not prevent us from banding together in a society for development work. The Modular Society should be formed in close association with the British Standards Institution, which would take care of the issue of any national standards arising from its researches. It would carry a small technical staff to give a service of information and advice to members; and its promotional work would include assistance to members who came up against difficulties with the bye-laws. Development on the human-scale module would be the Society's avowed aim and this should be set, to begin with, at 40 inches, but not too rigidly; other sizes of modular stock around 3 feet 4 inches should be included, not forgetting the need eventually for modular brickwork.

A private society is, I submit, the right instrument at the present time, because it would encourage the empirical approach, which is already solving problems (like the thickness-problem) that are baffling to theory unsupported by field work.

Without central direction in some form, we might wait a lifetime for results. Natural selection is not enough to improve the stock of building materials; there must be selective breeding.

DISCUSSION

MR. JAMES RILEY: I speak as a member of the industry, and in that capacity I feel that I am expressing the views of all of us this afternoon in paying tribute to the excellence of the paper which Mr. Hartland Thomas has just read, and in particular to the immense amount of pure research, investigation and analysis which went into its preparation.

In the same way, I wish particularly to stress that given, as we have seen, that a number of bodies have been working for varying periods, official, professional and industrial, the singular thing surely which has emerged is that so many of those independent bodies have reached much the same conclusion. That appears to me to be justification, above all, for the wisdom of the suggestion that Mr. Hartland Thomas has made, namely the formation of a Modular Society.

In such a way, it would appear that the results of this independent research can be brought together. Ideas can be pooled and a really strong case can be made out which we hope will enable the industry to march along on common lines in order to achieve the primary objective, cheaper building. I think Mr. Hartland Thomas has made it clear that the mere acceptance of modular co-ordination is not itself a panacea: in other words, it is not a complete means in itself of achieving the objective; but it is a most important contribution, and I do feel that the evidence which Mr. Hartland Thomas has amassed does prove this beyond all shadow of doubt.

Drawing upon the experience of my colleagues and myself, I should just like to give you one quick example of what modular co-ordination, modular planning, does mean in practice. I recently had an experience in which we were faced with the production of houses against a very urgent requirement. That requirement was absolutely vital, and urgency was the keynote. Because we were able to call upon standardized components through the adoption some years ago of modular planning, it was possible to run the whole gamut of design, production, arrangements for packing, the whole co-ordinated in such a way that from initiation—from the day the interpretation of basic design was first started—to the shipping of forty houses, only five weeks elapsed. That period obviously included estimation and basic planning. I do emphasize that the particular building of which I am speaking had not been made before. Unless we had adopted modular planning some years ago that achievement simply would not have been possible.

I do suggest that the industry as a whole would derive enormous benefit from the acceptance of modular planning as a principle; admittedly not rigidly. After all, we can accept a principle and accept also flexibility in its application. But I have put this example forward as a practical demonstration of the speed and simplification which can result from the adoption of modular planning.

I conclude by pledging, as I do wholeheartedly, the support of my colleagues and myself to the idea of a Modular Society. I believe tangible results must come from such a development. I recognize at the same time that I am speaking as a member of the non-traditional branch of the industry rather than the traditional, and yet, surely, if we are to take advantage of the experimental, research and developmental work which has taken place in the non-traditional sphere, then the whole industry must co-operate to secure the vital objective of economy in building.

I feel that a Modular Society might well prove to be the vehicle of that essential co-operation.

MR. BALMAIN: I also speak as one who has wrestled painfully with the problems raised by modular planning construction. I should like to associate myself with the last speaker in his compliments on the way the lecturer handled his paper. I think, however, that we really must bear in mind that the subject of Mr. Hartland Thomas's paper is the possibility of reducing building costs.

I think it is fair to say that there is no manufacturer of prefabricated buildings—I use that horrible word because people understand what it means—who has been able to carry on his business without adopting modular principles. I can say, as far as we are concerned, that I do not think we should be able to compete at all unless we had from the beginning worked on some sort of modular principle, since production costs for non-standard parts would be so high that it would be impracticable.

It is very interesting to see from the examples the lecturer produced how the solutions of the theoretical problems, which are very difficult, have been almost the same in all cases, but I think that a note of warning should be struck there. The reason why we have been able to solve a number of the practical problems involved is really because we are each a special case.

Mr. Hartland Thomas rightly pointed out that there is no satisfactory general theoretical solution of this problem, but you can get a number of satisfactory solutions in practice providing you adopt a system of your own and standardize wall-thickness. Although one can go a long way in respect of one particular system, there are very difficult problems when it comes to manufacturers making components for all types of construction on so-called modular lines. As the Standards Committee pointed out, it is a very involved and difficult problem. I think that the adoption of modular ideas is bound, in the end, to reduce building costs, as it has in the special case of prefabricated systems, and I think ultimately it can probably be extended to all building components. But there is a long road to go before we get to that satisfactory state of affairs, and I think the lecturer's suggestion of a Modular Society is a very excellent way of achieving the goal in the end. I feel quite strongly that no government body can do it on its own. I think the suggestion is probably a typical British compromise, and that in the end it will be the most satisfactory way of achieving the result we want.

MR. H. J. MANZONI: I am connected with a local authority and I should like to thank Mr. Hartland Thomas for being the immediate instrument of bringing this matter forward. I think really I ought first of all to thank Mr. Alfred Bossom for making this all possible, not only because of the importance of the subject, but because, for my sins, I have been the Chairman of the Building Divisional Council of the B. S. I., during a period when certain researches concerning modular co-ordination have been going on. The B. S. I. is very anxious that these investigations should continue. It has been said that there is no complete solution to the problem; well, Sir, I would only repeat the Americanism that if it is difficult we will do it, if it is impossible it will take just a little longer. But I do not accept the position that there is no single solution to this problem. The difficulty with any system of modular planning is that it is so difficult to get it moving. One great trouble is that there is no advantage for anybody at the moment in planning anything at all to any sort of grid as an individual project. But if the planning of all buildings were adapted to such a system, and had been adapted to such a system for some years, then the advantages, which are very great indeed, would appear. I made a note in the train coming along of some of those advantages. As I see it, to start with there would be a certain ease in planning, because one would know that the pieces would fit. Secondly, there would actually be a greater choice in the standard products than there is to-day. Then again, it would be easier to avoid cramping, which is usual in planning to-day, because one finds that having

started from the shell it is necessary either to cramp certain components, or to start again and enlarge the shell; and, of course, there would also be the enormous economy in the production of the pieces.

Now those advantages seem to me to be so very well worth while pursuing, since they all have a bearing on the eventual cost, that we ought to try to find some method of getting the thing moving. I am by no means tied to any particular module; I think there is a lot to be said for a module of human standard; 3 feet 6 inches is nearly a metre, but not quite. It is a difficult vertical module, but nevertheless it may be the right one. Somehow we have got to try and find what is the right module, but we ought to try and find a module which in itself will fit all dimensions, both horizontal and vertical, of practically all buildings. We ought to find one other than three inches or four inches, or something of that nature, which is anyway too small to be useful.

Now, if we are going to find a module, how are we going to set about it? I think Mr. Hartland Thomas's idea of a Modular Society has very great merit, but I am a little doubtful whether such a society could indeed do research to such an extent that it could solve these problems. I think really the function of such a society would be more that of doing propaganda amongst the professions and amongst the public; I do not think it is so difficult amongst the public, it is the professions that are going to be difficult. It is to some extent mixed up with this matter of birthright: it does seem to deny architectural expression and that is something we all hate, and therefore our greatest opponents, I am afraid, will be the architects and the designers. I am quite certain that the great public will accept anything which is going to bring the cost of building down, whilst not causing any deterioration in the environment that they are used to. If we can only get the propaganda across, not only to the public and the professions, but to the Government as well, I think the British Standards Institution could probably face the research and investigation with, I would hope, much contact with such a society. Therefore I am very much in support of this idea.

The other difficulty is this, that even when a module is found, or even when a module is suggested, you will get no advantage from it until it is put over in a big way. You must get a vast amount of building proceeding, on the system of modular planning, before you are going to get manufacturers to make their products to your modular dimensions, and there is a vast range of such products—not only wall linings, but fittings of all sorts, windows, doors, prefabricated staircases, in fact almost everything that goes into a house, or into a building of any sort.

How are you to get that across? There is only one way to my mind: it must be put across by the Government itself, with the help of local authorities, who are the only co-ordinated operators to-day with a building programme big enough to launch the project and encourage manufacturers to change over to modular sizes. Therefore I think the main task of the Modular Society is to convince the Government that there is something in it. We have got to be democratic, think out the thing ourselves, and then try to get the Government to adopt it, and not expect the initiative to come from them.

MR. RICHARD LLEWELYN DAVIES, B.A., A.R.I.B.A. (Sheffield Provincial Hospitals Trust): I should like first to thank Mr. Hartland Thomas for a most stimulating lecture. I personally found it most fascinating as it brought back to me the days, some years ago, when I was much interested in prefabrication, the recent history of which he has traced so well. Also I should like to support very strongly the broad approach to these problems, put forward just now by Mr. Manzoni. My own feeling in this matter is that the crux of the contribution which dimensional co-ordination can make to cheaper building lies in the point that Mr. Hartland Thomas made at the very beginning of his paper, when he referred to the gap between traditional and non-traditional building, and said that that was a gap which should not exist.

I agree that the essential problem which we are all most concerned with now is how to bridge that gap. In non-traditional building composed of comparatively large units which are factory-made—as pointed out by previous speakers—the concept of grid planning in dimensions such as 3 feet 4 inches or 4 feet is almost inevitable, and it is now broadly accepted by all main producers of that type of building. However, it remains true that the majority of building that goes on in this country does not fall into this class, but into the class which is partly traditional and partly—in so far as it does make use of standard windows and other factory produced components—in the field of modular co-ordination. The experience of most architects is that it is precisely this gap between the manufactured components that we have to introduce into building and the traditional material that we still use, and will continue to use inevitably over a vast field of building, that is the point at which the maximum study and research is needed.

I have lately been concerned with hospital building, which will rarely be on a large enough scale to justify a large programme employing wholesale prefabrication. I have sought with some energy, based on my previous interests in prefabrication with L. M. S., to apply the principle of co-ordination to building in traditional materials, and I have found it extremely difficult. The present position is such that you cannot really apply grid planning in a wholehearted way to traditional planning. What is the way forward? I think that Mr. Manzoni was right in saying that this was a difficult problem, and he was also right when he said it was a problem the solution of which was not impossible. But I also feel that we should beware of stressing too strongly the concept of grid planning, for while grid planning is essential in the design of prefabricated structures, I am no longer certain that it is essential in the application of dimensional co-ordination to traditional building. I am inclined to think that the concept of a related series of dimensions, which has been developed by Mr. Corbusier, amongst others, and which, in the very different field of Renaissance architecture, has recently been the subject of some most interesting historical researches, is probably the more fruitful line of progress on what is the essential problem of to-day. How can we deal with the discrepant elements of brick work, windows and doors, prefabricated or precast beams? How can we make all these elements which are being manufactured at different works up and down the country, architecturally more co-ordinated than they are to-day? That is the point where modular co-ordination must be brought in. How are we to reach that point? I think probably by a study devoted more to a related series of sizes than to a single dimension for grid planning, though, of course, related to some single dimension, in order to ensure that the development of standard sizes is in line and harmony with the tighter grid dimensions which must and should continue to be applied to prefabricated building.

MR. F. W. L. HEATHCOTE: I should like to add my very sincere appreciation of the paper we have just heard, which in itself shows such thorough evidence of field work. I should also like to say how much I appreciate as a visitor being able to join my own with other expressions of industrial opinion.

I speak as a representative of one of the manufacturers who are interested in modular co-ordination, and if there were one word in Mr. Hartland Thomas's paper which I should like to see in red ink and in italics, it is the word "magnet". (He spoke of Neufert's "magnet".) As industrialists I think we want some kind of magnet.

Industrialists work in their own specialized compartments; architecture has a whole world of interest and freedom, and I really feel that, as an industrialist, I should welcome the activity of the architectural profession in sowing this seed of modular co-ordination. I feel sure that if we had a Modular Society it would grow, without the

necessity for any greenhouse to force it. Therefore, I wholeheartedly support the general idea.

There is one case I might cite to illustrate the principle of the "magnet". This is the new type of domestic fire grate, which appeals to me because I am interested in foundry work. In recent years we have seen shop windows full of fire grates in a wide range of designs. Now manufacturers were able to offer those alternative designs to the public because they had some standard dimension to work to: in this case the sixteen inch fireplace which in years past had been widely used. If there had not been that dimension of sixteen inches I doubt whether we should have had such an attractive standard range in the shops to-day.

That was a magnet, and there is evidence of it in a small way. I feel that in years to come we shall find manufacturers offering items of equipment with a modular reference, and they will be able to go into production and make the best thing possible, because they feel that the public will take it, that there will be a market for it, and that their tools will be paid for. They will not have redundant stocks, and they will be happy; the money will come forward.

As Mr. Manzoni so very rightly said, it will take a long time, and only when you have got building based on this modular planning will manufacturers be attracted. I really feel that the magnet which our lecturer described will work. We have to let the thing grow, but if we plant the right seed, as he said in the last sentence of his paper, we shall develop something worth while.

MR. HENRY J. BROWN: Having thoroughly enjoyed the lecture this afternoon, might I say something in a little lighter vein, which nevertheless is of great importance to me: that is on the subject of acoustics. A very charming young couple recently bought a house next door to me and, within a short time, we had to send in a request that their practice on the piano might stop not later than eleven o'clock. This is a matter which is of great importance to many ordinary citizens, and I hope, with so many experts present, the point of acoustics will be kept in mind.

THE CHAIRMAN: Thank you, Sir. I am sure that the eleven o'clock hour is a matter of co-ordination!

MR. E. D. HINCHLIFFE: I should like, first, to say that I feel that Mr. Manzoni has really hit the nail on the head. I am a manufacturer of components for prefabricated building construction and I would stress that one of the most immediate and important things is to establish a module as quickly as possible, one that is firm and lasting. A manufacturer has, on large-scale production, to lay out a lot of money, both on development and production plant, and I would suggest that until a module is established he cannot lay out money adequately and properly. Until he spends his capital on plant and factories for mass production of components he cannot compete with traditional building, and the real purpose of establishing a module is to get down building costs.

Four years ago my firm went into prefabricated school construction based on eight foot three modular planning, which was the recommendation of the Ministry of Education. My firm has been associated with about five million square feet of construction on this basis. Now this module is being discarded in favour of three foot four inches. We have spent a lot of money, both in development and capital outlay for eight foot three modular planning. We appreciate the position and we are moving on to the three foot four inch grid but this matter must become firmly established before firms can lay out considerable sums of money on this type of production.

MR. BRUCE MARTIN, A.R.I.B.A.: I also should like to add my thanks to those of the

others to Mr. Hartland Thomas for undertaking this work. I think that to have done so at this time is extremely valuable.

I should like to make a few remarks about what I feel may be in the minds of many: on the one hand the need for freedom and fluidity of design, and on the other hand what may appear to be the imposition of a grid. It seems to me that the building industry has lacked for a very long time now what has existed, and what in fact promoted work, in other fields.

I should like to remind you of navigation. I think it is true to say that until the concept arose of putting lines on the plan of the world, navigation was very difficult. But once they were arbitrarily agreed by everybody, people began to know where they were, and they could relate their position in relation to the lines. That does not mean to say that, as a result, all our cities were laid out on a latitude and a longitude; on the contrary, that does not happen, but it has meant that we have a reference system.

It seems to me that on this question of a grid the same thing applies: we require a reference system. It does not follow, therefore, that every component must be put on the lines; in fact this may lead to many difficulties, but it does mean that by having this reference system we can then, amongst ourselves, determine which components should be on the lines, which should not, and what should be the relations of the different kinds of components to those lines.

Mr. Manzoni referred to the enormous range of components that exist in British standards for building. He also suggested, I think, that there might be a certain difficulty in tying them up. I do not see that this need necessarily be so, because it seems to me that of all the components that already exist, many of them are, so to speak, independent of the grid reference system. I am thinking of such things as the whole range of electrical components, the whole range of fire equipment and apparatus of various kinds.

I should like in conclusion to say that the modular grid that has been proposed is, to my mind, the beginning of an enormous step forward in the building industry, because it will be a method by which we can all have a basis for talking about this work.

THE LECTURER: I do not feel that much, if anything, has come up in the discussion that requires answering in the controversial sense.

I was very glad indeed to have the strong response from the industrial side of this work, and to hear support for the idea of a Modular Society. The contributions by Mr. Llewelyn Davies and Mr. Bruce Martin which, although I know they were not framed beforehand jointly—at least I do not think they were—do amount to a joint contribution, introduced into the discussion something that I have not dealt with very much. I would agree that in pursuing the study of modular planning, as indeed I said in my paper, it would be wrong to go forward rigidly on definite lines, because we have not yet got sufficient area of agreement or sufficient evidence from experience. I was very much impressed with what was said about the possibility of certain kinds of "traditional building", which I prefer to call the "wet and heavy", being co-ordinated in reference to a dimensional grid, but on a system of preferred sizes in series. I am sure that we shall find solutions of this kind presenting themselves as we develop.

Indeed, as I said before, I do not feel that I have anything in the sense of controversy to answer. I should be grateful though, as we have had several expressions of support in the discussion for the suggestion of a Modular Society, if the Chairman would sound the meeting in some way—perhaps with a show of hands or a chorus of hisses or something—to find out whether it would be worth while, perhaps at another time or in another place, to come together to see what we can make of the

idea. I doubt if there is a better occasion than this, when I know the room is full of people who are well versed in the subject to try it out.

THE CHAIRMAN: I doubt if it would be quite fair for there to be a show of hands in respect of those in favour of the principle which the lecturer has proposed, because there are many people here who have not had time to think over it. At the same time, if those members of the audience who are instantly in favour, at first impression as it were, of the proposal for a Modular Society would like to lift their hands, I should be very happy, and I think the lecturer would be much interested. May we do that before I wind up the proceedings?

Most of the audience raised their hands.

Well, Sir, I think you have got a quorum!

There is only one thing I should like to say, which is that I am sorry Mr. Alfred Bossom has had to go the House, and is not here to see the resounding success of this first of his lectures which he has endowed. We could not have had a better lecturer, or a better subject, or a better audience.

A vote of thanks to the Lecturer was carried with acclamation.

MR. E. MUNRO RUNTZ, F.R.I.C.S. (Chairman of the Council of the Society): On your behalf I should like to propose a vote of thanks to Mr. Howard Robertson for occupying the chair this afternoon in such a kindly and able manner, particularly bearing in mind all his responsible jobs—he is amongst other things President of the R.I.B.A.

I should also like to take this opportunity publicly to thank Mr. Bossom, on behalf of the Royal Society of Arts, as Chairman of its Council, for his generous endowment. I regret he has had to go to the Commons, but I understand he has gone there in order to try and get some degree of modular co-ordination!

I have been much impressed by Mr. Hartland Thomas's suggestion of the formation of a Modular Society, and perhaps I may remind you that this Society has been the parent of many other societies which are quite famous to-day, and that this house was their birthplace. I feel that if a Modular Society should be formed, then my Council would be very willing to help it in order to get it on its feet.

The vote of thanks to the Chairman and to Mr. Bossom was carried with acclamation and the meeting then ended.

SOME BRITISH BIRDS OF PREY

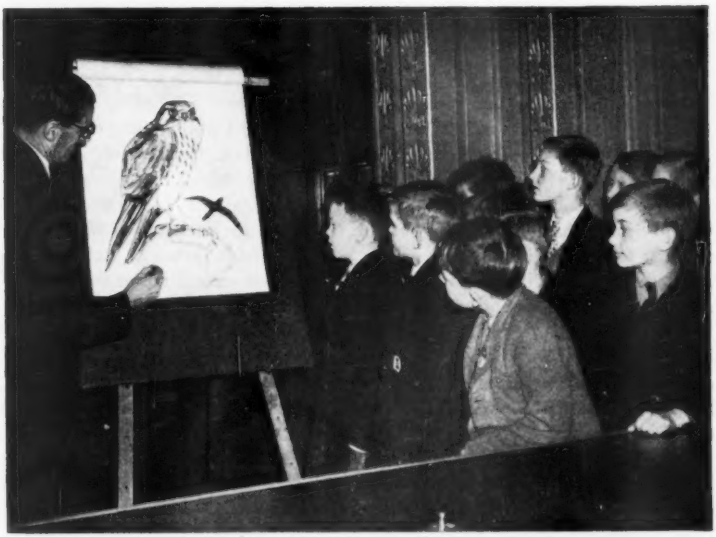
A Dr. Mann Juvenile Lecture by

LIEUTENANT-COLONEL DAVID WOLFE-MURRAY ("Fish-hawk")

Wednesday, 31st December, 1952

I propose this evening to deal with some of the less well known British birds of prey, but before doing so I wonder how many of you know the difference between hawks and falcons? We gaily call everything except owls, "hawks"—but, in fact, there is only one true hawk resident in Great Britain, and one which occurs very seldom, so, as there are quite a fair number of the *Raptores*, as we call them, it would often be more correct to talk of falcons rather than hawks.

As with all rules there are exceptions to this, and in birds we find types which strictly speaking belong to neither of these two main groups, but we will deal with them later on.



The young audience watch the lecturer's lightning sketch of a Hobby, one of the many chalk drawings with which he illustrated his lecture

The Sparrowhawk, from a water-colour painting by the lecturer

Now the differences between falcons and hawks, lie in: (*a*) Colour of the eye; (*b*) shape of the wing; and (*c*) shape of beak. Hawks have yellow eyes, while falcons have brown ones. Hawks have rounded wings, the 4th visible primary being the longest; falcons have pointed wings, the 2nd visible primary being the longest. Finally, hawks have curved beaks while falcons have notched beaks.

The Sparrowhawk is our true English hawk and the Kestrel our commonest resident falcon. So just to begin with I will do a quick sketch of each, as they show all the three differences very clearly, and then we can go on and see our rarer and more interesting examples of the two groups and also the exceptions.

Most people seem to think because *Raptores* stand upright, look you straight in the face, and have hooked beaks and strong talons, that they are savage and dangerous; but nothing is more untrue. They are really delightful people and some that I have had became as tame as any parrot, and none were really bad tempered.

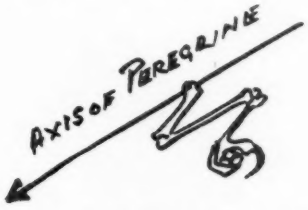
Since we in England have more falcons, let us begin by talking about them. Pride of place must go to the Peregrine, the royal hawk of falconry days, and unquestionably the boldest, most powerful of our British falcons.

Peregrines are usually found round the rocky coasts of the West Country, Wales and Scotland, though during the autumn they are great wanderers, especially the young birds, and may be met with almost anywhere. They are

wonderful fliers, and it used to be said that they flew round the world before they settled down in their own eyries.

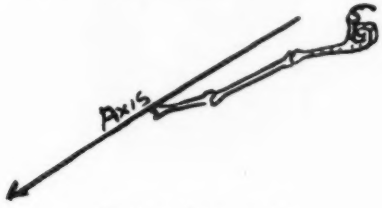
All true falcons strike their game down in flight, and there are many wild and silly stories told of how this is done. I have been told by an old ghillie that they hit their game with their wings. Well, if you have ever seen a Peregrine "stoop" you would realize at once that if he hit with his wing, the wing would come off!

It is really done like this: the falcon gets high above his game, and then comes rushing down at about 150–180 m.p.h. His feet are his weapons and these are carried clenched like a fist, but the long hind claw comes out and in front of the curled up "fingers". Let me draw it for you:



(*Leg bones and foot at moment of striking game*)

Now when this living dagger hits the victim, it jars him and cuts into and through the flesh and bone; the shock to the falcon is taken up by the leg joints and the position of the foot and leg *after* the blow is like this:



(*Position after the strike*)

Falcons do not usually seize their game. They kill it in the air, and then return to collect the fallen body.

So much for falcons striking their game. Hawks work by surprise; they are sprinters and seize their game in the feet, killing it with a bite in the neck. No hawk or falcon is intentionally cruel. They are experts at their jobs, and cause little or no suffering to their victims.

Another lovely falcon is the Hobby, a summer visitor of real beauty, and a most wonderful flier; indeed, it can catch dragon flies and you all know how they can fly and dodge about in the air. It can also catch swallows and swifts,

so you can see that it must be pretty good as its job. Unfortunately, Hobbys are rare, as egg collectors persecute them unmercifully, so that not many of us have a chance to see them. And when we do find a pair, we tell no one, so as to try and save the nest from being robbed. The last of our falcons to-night will be the Merlin, which breeds on our wilder moors in Devon, Wales, Derbyshire and Scotland. It is a small bird, but is a plucky little person and will tackle anything in defence of its young.

Now that we have dealt with three falcons, let us think of some of the odd birds, which are neither true hawk nor true falcon. The buzzard, the eagle, and the harrier come into this mixed group. Personally I feel that the harriers

The Peregrine, from a water-colour painting by the lecturer

are the most interesting of these, so we will think of them first, and then if we have time we can deal with the other two.

There are three kinds of harrier to be found in Great Britain—the Marsh, the Montague, and the Hen. Both Marsh and Montagues are found on the Norfolk Broads, while the Hen harrier nests in Orkney and is most often seen in England during migration.

All harriers have a very characteristic flight, which once seen is easily remembered and is a sure method of identifying the group, but *not* the species. My next drawing will be of a Hen harrier, male, and will show the typical wing position; it is a high winged glide, interspersed with periods of flapping.

Harriers all hunt in the same way: they quarter the ground quite low, and work almost like dogs, swinging this way and that, and then coming back and working up wind again. They seize their prey on the ground, and eat large numbers of voles and frogs, as well as young birds. They have much longer legs than either hawks or falcons, and the wing shape is rather half and half, having the *length* of the falcon's and the *round end* of the hawk's. These birds are migrants like the Hobby, and it is seldom that one sees them during the winter; if you do see one, then the betting is that it is a Hen harrier. Harriers are peculiar

Marsh harrier dropping food to his mate who has come up to meet him above the nest: a rough sketch from life made by the lecturer

in another way, the females differ a great deal from the male, in colour and markings, while in the Marsh harrier the young are quite unlike either of their parents!

I am afraid that these differences are too complicated to deal with in a general talk, but whatever the sex or age of a harrier, they all fly alike, so remember their lovely high ring glide.

Perhaps one of the loveliest things to watch is the male harrier passing food to its mate, in the air. As the male comes near the nest, he calls, and his wife

leaves the eggs and comes to meet him in the air. She flies below him, looking up to see when he drops the food in his claws; as it falls, she rolls over on to her back and catches the food in one foot, rolls back and then goes down to the nest. It is a lovely thing to see and I know that my own sketch cannot possibly do justice to the wonderful skill of the birds.

At the end of the lecture the audience went downstairs to the Library, where the Society entertained them to tea.

GENERAL NOTES

THE CROWN AND THE ROYAL ARMS

The Society has received from the Council of Industrial Design a copy of the drawings of the Crown and the Royal Arms prepared by Milner Gray, R.D.I., F.S.I.A., for use on Coronation souvenirs. The crown is designed in three versions: for die-stamping, embossing, or one-colour outline; for solid colour; and for full colour. The Royal Arms are shown in a simplified version. These designs are traditionally correct, but are treated in a contemporary manner. They were commissioned by the Council as a guide to manufacturers, and may be obtained from them, at Tilbury House, Petty France, S.W.1, at a cost of £1.

FREE EVENING LECTURES AT THE V. & A.

The second series of free evening lectures which are being given at the Victoria & Albert Museum this winter, on Wednesdays at 6.15 p.m., began on January 7th. The lectures will be mainly concerned with subjects connected with the throne, and they will include: "The Robes and Insignia of the Order of the Garter", by John L. Nevinson (January 14th), "The Coronation Robes", by Lawrence E. Tanner, Keeper of the Muniments and Library, Westminster Abbey (February 4th), "Hampton Court Palace", by John Summerson, Curator, Sir John Soane's Museum (February 18th) and "The Crown Jewels", by Major-General H. D. W. Sitwell, Keeper of the Jewel House, H.M. Tower of London (March 4th). There will also be a lecture by Charles H. Gibbs-Smith, Keeper in Charge of the Wellington Museum (March 11th), on the new museum at Apsley House, a notice of which was published in the *Journal* of 25th July 1952 (page 635), at the time of its opening.

No admission tickets are required for any of these lectures, and they will all be given in the Museum Lecture Theatre (entrance in Exhibition Road).

END PIECE

The judging of the entries in this year's Industrial Art Bursaries Competition, which is at the moment in progress, has provided a striking instance of the consistent interest which the Society has taken in industrial design throughout its history. While the Jury were in the Library considering this year's entries in one of the textile sections, upstairs in the Council Room some textile designs submitted to the Society in the 1750's were being selected for reproduction in the forthcoming History of the Society.

ERRATUM

In Dr. E. G. Richardson's paper on "The Science of Musical Instruments" published in the *Journal* of 12th December, 1952, the uppermost and lowermost of the three traces illustrated in Figure 4 (page 63) were printed in an incorrect order. They should, therefore, be transposed and re-numbered 4 (*c*) and 4 (*a*) respectively.

CORRESPONDENCE

PIONEERS OF FLYING MACHINES

From JOHN J. CALDER, ARDARGIE, FORGANDENNY, PERTHSHIRE

In one of the extracts from past *Journals* published in the Centenary issue, on page 23, there are some statements which might lead your readers to believe that Maxim was the pioneer of flying machines.

The real pioneers were, of course, Lilienthal, after whom the Headquarters of the German Air Force was named, in Germany, and Percy Pilcher, a Londoner, in Britain. Pilcher, after retiring from the Navy, studied shipbuilding at the Fairfield Shipbuilding Company, Glasgow, and later, about 1892, became Lecturer in Shipbuilding in Glasgow University. He became interested in the possibility of flying, and for many years made experiments in gliding as a preliminary. When satisfied with his results he approached Maxim, and they jointly built the first machine at Rochester; unfortunately, the metals used were too heavy for the power available, and the experiment was a failure. I had been asked by Pilcher to sit beside him and be one of the first people to fly but, sharing the common doubts of its safety, I declined.

Pilcher continued his experiments, and was killed near Rugby; the same fate befell Lilienthal in Germany. As Admiral Roche, of the United States, who had studied shipbuilding under Pilcher, said, "Poor Percy, he blazed the trail which others followed". I am always surprised how few people in the R.A.F. have heard of Pilcher, but when I asked my friend Air Marshal Lord Tedder who was the pioneer of flying, he at once replied "Pilcher". The Scots and the Americans are, perhaps, too ready to boast of the inventions made by their compatriots, but the English certainly err in the other direction.

NOTES ON BOOKS

A HISTORY OF SCIENCE, TECHNOLOGY AND PHILOSOPHY IN THE EIGHTEENTH CENTURY. *By A. Wolf. Second Edition revised by D. McKie. George Allen & Unwin, Ltd.*, 1952. 60*s*

All students of history will welcome the appearance of a second edition of this very important work, first published in 1938, revised by such a competent authority as Dr. McKie. A sentence from the preface to the first edition admits one into the mind of the author: "At a time when large sections of the civilized world are reverting to barbarism, it is especially stimulating to study the age in which Europe was struggling, and successfully struggling, towards a state of enlightenment. What mankind has achieved once it will assuredly achieve again, and achieve, it is to be hoped, with a fuller realization of the need of eternal vigilance as the price of freedom, so essential to human progress". It is in this atmosphere of confident hopefulness and vigilance that one will peruse this fascinating and valuable work.

In the sixteenth and seventeenth centuries, through the quickening spirit of the Renaissance, a great extension of intellectual activities took place, notable advances were made in the study and understanding of natural phenomena, and the foundations of various branches of natural science were laid. In the seventeenth century, also, philosophy enjoyed its golden age. It was into this heritage that the eighteenth century entered; and in the work before us the author gives a fully documented, always interesting and often fascinating account of the whole of eighteenth century intellectual and industrial life. This was "the age of Enlightenment" and of the widespread diffusion of knowledge throughout the upper and middle classes of society;

the education of the working classes had not yet begun. The eighteenth century was the age of encyclopædias and periodicals, and an age which saw the birth of such public institutions as the Royal Institution of Great Britain for diffusing the knowledge and facilitating the general introduction of useful mechanical inventions and improvements, and for teaching the applications of science to the common purposes of life; and in the middle of the century, also, there was founded the Royal Society of Arts, " for the Encouragement of Arts, Manufactures and Commerce in Great Britain". In this century, as the author remarks, knowledge was applied in every possible direction in order to improve the conditions of human life; and all the intellectual and moral forces of the age were harnessed to the chariot of human progress. It is to giving an account of the development of knowledge and of its applications that the author so successfully devotes himself.

In the eighteenth century great advances were made in all branches of science: mathematics and mechanics, astronomy, physics and meteorology, chemistry, geology, geography, botany, zoology and medicine; and the story of these advances is most ably told within a biographical framework. Here we make, as it were, personal acquaintance with the leaders of thought and action, listen in to their conversation and get some understanding of their characters. It is a very human story which should make an appeal not only to every student of science but to every educated layman. On the history of the advances made in pure science there follows an account of the developments in the various fields of applied science—agriculture, textiles, building, transport, power plant and machinery, the steam engine, mining and metallurgy, industrial chemistry, mechanical calculators and telegraphy. The scope of the work is thus seen to be very wide.

To understand the eighteenth century, the author points out, something more is required than a knowledge of its achievements in science and technology, and the book ends with a study of the history of developments in psychology, the social sciences and philosophy, which exercised a very powerful influence on men's minds and outlook. The more important traits in the character of the eighteenth century are "its secularism, it rationalism and its naturalism, which between them helped to create a broadminded humanism". It was sought to make the century an "age of reason", to secure freedom of thought and expression, to teach toleration and to fight oppression, a movement prominently associated with the name of Voltaire. But the gospel of humanism and humanitarianism did not prevail, and the optimism expressed by the author in the passage quoted at the beginning of this review, is moderated by his concluding words: "But times have changed and not for the better. Once more the world urgently needs a Voltaire, indeed a whole army of Voltaires, to fight against the new forms of darkness and fanaticism which threaten to destroy civilization". This is a book which everyone should read.

ALEX. FINDLAY

ENGLISH COSTUME FROM THE SECOND CENTURY B.C. TO 1950. *By Doreen Yarwood. Batsford*, 1951. 35*s*

Mrs. Yarwood has attempted, in 282 pages, to produce a book "intended primarily for those embarking on a general but comprehensive study of the history of English Costume", and to serve also as a reference book for students. Such a task would be difficult indeed and the only satisfactory method would be that of the historian who presents no more than the salient features of his subject, emphasizing significant changes and excluding everything of minor importance.

Mrs. Yarwood, however, has preferred to pack her pages with as much as they will hold; so tightly, indeed, as to crush the material and to make the contents difficult to extract. Precious space expended on the costume of ancient civilizations, which has little bearing on English Costume, might more usefully have been given to

relevant matter and to clarifying descriptions which, as they stand, are far from lucid. The student, struggling to understand the costumes of the 14th and 15th centuries, will find it difficult to see the wood for the trees.

The author has obviously taken great pains and has studied many books on the subject though the Bibliography on pp. XIII–XIV has some strange omissions. The works of Strutt, Leloir, Linthicum, Armand, Enlart and Piton are not mentioned, though these are vastly more important—and reliable—than many of those listed. Among the later Fashion journals it is remarkable that the *Tailor and Cutter* is not included.

Errors committed by previous writers have been allowed to reappear in the present volume; not for the first time we are told that the "steeple hennin" was an English mode, though modern research has shown this to be incorrect. The "sideless surcote" of the 14th century was not worn "on top of the cotehardie", both being over-garments. There is no mention of the "garnache". The statement that ladies' evening gowns of 1795–1805 might have "trains 7 to 8 yards long" is certainly original.

The reader would suppose that the Victorian "bustle" only appeared *after* the crinoline, though in fact it was worn from 1820 to the arrival of the cage. The revolutionary changes heralded by the "Tweedside" for men and the "walking dress" for women are scarcely noticed and the distinctive feature of the dress of the '90s—the famous "gored skirt"—receives no mention.

The book is copiously illustrated; the eleven plates in colour are charming. The line drawings give a mass of details but the full-length figures, especially those of the Victorian period, fail to reproduce the subtle quality of "smartness" which they had in life.

The book will be useful to students who employ it in conjunction with more reliable authorities.

C. WILLETT CUNNINGTON

SHORT NOTES ON OTHER BOOKS

THE CHOICE OF WORDS. *By V. H. Collins. Longmans, Green*, 1952. 9*s* 6*d*

This collection of synonyms is concerned to show the distinctions between nearly related words, and to make clear by examples the shades of meaning which have developed in once identical words, with emphasis on current use. The words are arranged in groups; an explanation of differences in the group is accompanied by advice on proper and improper use. There is a list of words of which the uncertain should be wary, and an index.

LEAVES OF GOLD. *George M. Whiley Ltd.*, 1951.

This handsome book, which is illustrated with line drawings by John Minton, tells the history of the craft of gold-beating, and describes modern production methods and uses of gold leaf.

TREASURES OF A LONDON TEMPLE. *Taylor's Foreign Press*, 1951. 30*s*

A number of experts here catalogue and describe the ritual plate, mantles, and furniture of the Synagogue of the Sephardic Community, at Bevis Marks. Twenty photographs follow the catalogue, and there is an index.

PORTRAIT PAINTING. *By Henry Carr. Studio publications*, 1952. (*How to do it series, no.* 45.) 18*s*

This book follows the usual plan of the series, with practical advice on methods and materials, and the description of the painting of a portrait which is illustrated at several stages, followed by notes on reproductions, some in colour, of a number of portraits.

FROM THE JOURNAL OF 1853

VOLUME I. *7th January*, 1853

From some remarks on the* Fine Art Section of the Premium List, *the subjects of which had been published in the previous issue

In regard to the third section of the List, "Art Designs for Manufactures", a few words may be added as to the direction that ornamental art is likely to take in this country. The question of Design in this branch is one that has not till very lately taken a substantial hold on this country. At the first impression of its importance, and from seeing the baldness in design of many of our manufactures, the taste of the public, as well as the artist, in many cases, rushed towards the opposite defect—over-elaboration; but that the English taste will eventually, perhaps, after a few oscillations, find its point of rest not far from *simplicity*, there is little doubt. A pure taste is even now gaining force among us. Art is but part of a whole. It is one manifestation of the spirit of the people, and that kind of art will alone take root and flourish that is in accordance with the national character. In the belief, therefore, that utility and simplicity will be the character of our art designs for manufacture, these few words are addressed to those who may be disposed to become candidates in this branch for the Premiums of the Society.

Some Meetings of Other Societies

MON. 12 JAN. Geographical Society, Royal, S.W.7. 8.15 p.m. Anton Bruun: *Danish Deep Sea Expedition, 1951–52.*

Imperial, Institute, S.W.7. 5.30 p.m. K. G. Bradley: *British Commonwealth To-day: Northern Rhodesia and Nyasaland.*

Purchasing Officers Association at the Royal Society of Arts, W.C.2. 6.30 p.m. H. F. Barnes: *Temperature Measuring Instruments with some reference to Automatic Temperature Control.*

TUES. 13 JAN. Illuminating Engineering Society at the Lighting Service Bureau, 2, Savoy Hill, W.C.2. 6 p.m. P. D. Figgis: *Some Aspects of Power Station Lighting.*

Japan Society of London, at the Victoria & Albert Museum, S.W.7. 5.30 p.m. I. MacDonald: *A Japanese Sparta.*

Mechanical Engineers, Institution of, Storey's Gate, S.W.1. 5.30 p.m. J. H. Alden: *Life Assessment Methods for Commercial Vehicles.*

WED. 14 JAN. British Decorators, Incorporated Institute of, at the Building Centre, Store Street, W.C.1. 6.30 p.m. Sir Hugh Casson: *Architecture and the Decorative Arts.*

British Kinematograph Society, at Film House, Wardour Street, W.1. 7.15 p.m. C. B. Watkinson: *Modern Tendencies in 16 mm. Projector Design.*

Electrical Engineers, Institution of, Savoy Place, W.C.2. 5.30 p.m. G. W. A. Dummer and D. L. Johnston: *Printed and Potted Electronic Circuits.*

Locomotive Engineers, Institution of, at the Institution of Mechanical Engineers, Storey's Gate, S.W.1. 5.30 p.m. A. S. Robertson: *Limitations on Train Performance with Electric Traction.*

Petroleum, Institute of, at Manson House, 26, Portland Place, W.1. 5.30 p.m. H. C. Rampton *Methods of Hydrocarbon Type Analysis.*

Sanitary Institute, Royal, 90, Buckingham Palace Road, S.W.1. 2.30 p.m. Roy C. Hoather: *Fluorides in Water Supplies.*

Victoria & Albert Museum, S.W.7. 6.15 p.m. J. L. Nevinson: *The Robes and Insignia of the Order of the Garter.*

FRI. 16 JAN. Geographical Society, Royal, S.W.7. 5 p.m. L. S. le Page and A. L. P. Milright: *Radar and Ice.*

Mechanical Engineers, Institution of, Storey's Gate, S.W.1. 5.30 p.m. H. N. Pemberton: *Welding in Marine Engineering.*

SAT. 17 JAN. Horniman Museum, Forest Hill, S.E.23. 3.30 p.m. W. J. L. Sladen: *Life and Scenes in the Antarctic.*

MON. 19 JAN. Electrical Engineers, Institution of, Savoy Place, W.C.2. 5.0 p.m. *The Parallel Running of Private Generating Plant with the Grid System* (*Discussion*).

Imperial Institute, S.W.7. 5.30 p.m. Colin Black: *British Commonwealth To-day: Southern Rhodesia.*

TUES. 20 JAN. British Architects, Royal Institute of, 66, Portland Place, W.1. 6 p.m. W. A. Allen: *The Modern American Factory.*

Electrical Engineers, Institution of, Savoy Place, W.C.2. 5.0 p.m. *Measurements of Magnetic Permeability* (Discussion).

Industrial Transport Association, at the Royal Society of Arts, W.C.2. 6.30 p.m. L. R. Hickson: *Paints—New Era. Application to Commercial Vehicles.*

Refrigeration, Institute of, at the Institution of Mechanical Engineers, Storey's Gate, S.W.1. 5.30 p.m. E. C. Bate-Smith and Putnam Eaton: *The Freezing, Chilling and Cold Storage of Meat.*

WED. 21 JAN. Electrical Engineers, Institution of, Savoy Place, W.C.2. 5.0 p.m. *Some Difficulties in the Teaching of Electrical and Mechanical Resonance* (Discussion).

Folk-Lore Society, at University College, Gower Street, W.C.1. 7.30 p.m. K. M. Briggs: *Magical Books in 17th Century England.*

Victoria & Albert Museum, S.W.7. 6.15 p.m. H. S. London: *The History of the Royal Arms.*

Wool Education Society, at the Royal Society of Arts, W.C.2. 7 p.m. J. E. Nichols: *Improving the World's Wool Supply: the Role of the Biologist.*

THURS. 22 JAN. Chemical Society, at the Royal Society, Burlington House, W.1. 7.30 p.m. R. P. Linstead: *Discoveries among Conjugated Macrocyclic Compounds.*

Road Transport Engineers, Institute of, at the Royal Society of Arts, W.C.2. 6.30 p.m. J. W. Taylor: *Organisation for the Maintenance of a Large Fleet.*

FRI. 23 JAN. British Sound Recording Association, at the Royal Society of Arts, W.C.2. 7 p.m. E. A. Vetter: *Some Physiological Factors in Quality Appreciation.*

Mechanical Engineers, Institution of, Storey's Gate, S.W.1. 5.30 p.m. G. H. Asbridge: *Design of Precision Grinding Machines.*

SAT. 24 JAN. Horniman Museum, Forest Hill, S.E.23. 3.30 p.m. G. R. G. Worcester: *Cyprus: Ancient and Modern.*